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Lower and Middle Triassic sediments in the Jajarm area, eastern Alborz, North Iran

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Abstract

Lower and Middle Triassic sediments assigned to the Elikah Formation crop out northwest and northeast of Jajarm (eastern Alborz). These can be subdivided into two facies groups, a carbonate and siliciclastic facies in the lower part and a carbonate facies in the upper part, comprising eight members. The lower as well as the upper boundary is disconformable and marked by lateritic-bauxitic horizons. The sedimentary environments range from littoral, tidal and shallow shelf to open shelf-sea. The rather poor foraminifer fauna indicates an Early to Middle Triassic (Scythian-Ladinian) age of the succession.

Key-words : Elikah Formation, Triassic, Jajarm, eastern Alborz, North Iran.

Introduction

Lower and Middle Triassic sediments are widely distributed throughout North Iran (Alborz Range). They consist mainly of carbonate rocks, being deposited on a vast platform along the shelves of Paleo-Tethys and Neotethys (Seyed-Emami, 2003). These have been named as the Elikah Formation by Glaus (1964). The type section of the Elikah Formation is located in central Alborz near to the village of Elikah (Fig. 1 & Pl. 1/1), where it has a thickness of 295 meters. Here it overlies apparently conformably, the Upper Permian rocks (Nesen Formation) and can be subdivided into two members. The lower member (95 m) consists of thin-platy, grayish to pink marly limestones, with few dolomitic and oolitic beds. Many bed-planes are crowded with worm-tracks, for which they have been called "calcaire vermiculé" by Dellenbach (1964). The upper member (200 m) consists of well-bedded, dense to fine-crystalline, yellow-gray dolomites and dolomitic limestones. The upper boundary to the siliciclastic and molassic Shemshak Formation (Norian-Bajocian) is disconformable and marked by a lateritic horizon.

Except in the Jolfa area in northwestern Alborz (Fig. 1), where the Permo-Triassic boundary is rather continuous (Stepanov et al., 1969; Golshani et al., 1986), elsewhere along the Alborz Range, the Elikah Formation overlies with a distinct disconformity Upper Permian or even older strata (Seyed-Emami, 1971, 2003) and may have thicknesses up to 1000 meters. The age of the Elikah Formation can be deduced by the rather poor fossil content, mainly concentrated in the lower part. The main fossil taxa are foraminifers, pelecypods, ammonoids and conodonts, indicating an Early and Middle Triassic age for the formation. In few localities such as Aruh area (west of Firuzkuh) and Veresk area (northeastern Firuzkuh) along central Alborz and Shahrud area in eastern Alborz (Fig. 1), where the pre-Shemshak erosional phase (Early Cimmerian tectonic event) has not been deep enough, a light algal limestone up to100 m (Aruh Limestone Member) builds up the top of the Elikah Formation (Zaninetti et al., 1972; Stampfli et al., 1976; Nabavi, 1987; Jahani, 2000; Vaziri and Majidifard, 2001; Seyed-Emami, 2003) and age of the

Fig. 1 Position of the Alborz Range in northern Iran and the Elikah Formation in type section (1) and Veresk area (2) in central Alborz and Shahroud area (3), Ghoznavi area (4) and Jajarm area (5) in eastern Alborz.

Elikah Formation span up to Late Triassic (Carnian).

The Elikah Formation in the Jajarm area

Well-defined outcrops of the Elikah Formation occur along the Uzum Mountain (Kuh-e-Uzum), northwest and northeast of Jajarm (Fig. 1). The studied section was measured along a road cutting in south-north direction the Uzum Mountain with the following coordinates: N 56°. 31′, E 37°. 03′. Here, the Elikah Formation overlies disconformably, via a lateritic-bauxitic horizon (2 m), Late Permian strata (Pl. 1/3, 4). On the top again the boundary of the overlying Shemshak Formation is disconformable and marked by a thick bauxitic horizon (7 m), and is mined for the Jajarm Alumina factory (Pl. 1/8).

The measured section has a thickness of 216 meters (Pl. 1/2) and can be subdivided into two facies groups, a carbonate and siliciclastic facies in the lower part (58 m) and a carbonate facies in the upper part (158 m) with a total of eight members.

Lithostratigraphic description of the section

Base: The Elikah Formation in the Jajarm area disconformably overly a thick laterite-bauxite horizon (2 m), which belongs to Late Permian (Pl. 1/3, 4). This laterite-bauxite horizon also disconformably overly fossiliferous Limestones of the Mobarak Formation with Early Carboniferous (Visean) age. These rocks contain the following microfossils:

Bisphaera sp., *Brusia* sp., *Darjella* sp., *Earlandia* sp., *Endothyra* sp., *Kohichiopora* sp., *Tournayella* sp., *Tuberitina* sp., *Umbella* sp.

1) Carbonate and siliciclastic facies:

This facies with thickness of 58 m and Early Triassic (Scythian) age is subdivided into 5 members (Fig. 2):

Member 1 (7 m):

Alternation of white, coarse grained, medium and

thick-bedded quartz sandstones.

Member 2 (8 m):

Alternation of red sandy conglomerates, purple to red, medium-bedded sub arkose sandstones and quartz arenites with intercalations of reddish, thin-bedded shale. Sandstones have abundant opaque minerals and iron oxides that acted as a binding other minerals. Quartz minerals in sandstones can be observed with amorphous appearance, weak to medium sorting and subrounded. This mineral is accompanied by little amounts of metamorphosed quartz and relics of altered feldspars (anhedral) as well as concentrations of phyllosilicate minerals and iron oxides. Some carbonate minerals and tourmaline are also present with amorphous appearance. This member has sedimentary structures such as lamination and cross lamination.

Member 3 (12 m):

Brick-red, thick-bedded calcareous sandstones with cross-stratification followed by white, thick-bedded quartzite, thin-bedded shales, iron-bearing sandy limestones and white, medium-bedded quartz sandstones.

Iron-bearing sandy limestones have been slightly dolomitized and can be categorized as chemical sedimentary rock that contains allochemical and detrital components. The existing biological allochems (macro- and microfossil fragments) of carbonate origin have been vastly replaced by carbonate minerals and partly by iron oxides.

Ferruginous carbonate micritic particles are scattered in the rock texture. Carbonate minerals mostly reveal amorphous crystalline habit with locally iron impregnations. The existing fractures and porosities of the rock have been filled with coarse grained calcite (sparite and mosaic) as a dominant phenomenon.

Member 4 (12 m):

Buff and light green calcareous shales with intercalations of grey, medium-bedded shaly limestones with small gastropods.

Member 5 (19 m):

Alternations of buff to light grey vermicular limestones and yellowish, thin-bedded calcareous shales with abundant biotrubation. Besides bivalves (*Claraia*), serpulids (*Spiorbis*) and the following foraminifers occur:

Earlandia sp., *Glomospirella* sp., *Glomospira* sp., *Meandrospira* sp., *Rectocornuspira* sp.

2) Carbonate facies:

This facies with thickness of 158 m and Middle Triassic (Anisian-Ladinian) age is mainly a carbonate facies and subdivided into 3 members (Fig. 2):

Member 6 (51 m):

Alternations of light to dark-grey and buff, thin-bedded dolomitic limestones with intercalations of yellow and light green, thin-bedded calcareous shales (Pl. 1/5) and the following foraminifers:

Ammodiscus sp., *Angulodiscus* sp., *Glomospirella* sp., *Glomospira* sp., *Meandrospiranella* sp., *Meandrospira* sp., *Pilaminella* spp., *Semiinvoluta* sp., *Tolypammina* sp. (Pl. 2/1-8).

Member 7 (44 m):

Dark-grey, thin to thick bedded dolomitic limestones with ostracods (Pl. 1/6) and the following foraminifers:

Glomospirella sp., *Glomospira* sp. (Pl. 2/9).

Member 8 (63 m):

Buff and grey, medium and thick-bedded dolomites with flat to wavy stromatolitic structures (Pl. 1/7) and the following foraminifers:

Aeolisaccus? sp., *Bispiranella*? sp., *Diplotremina*? sp., *Earlandia* sp., *Glomospirella* sp., *Glomospira* sp., *Nodosaria* sp., *Ophthalmidina* sp., *Planiinvoluta* sp., *Spiriamphorella*? sp., *Textularia* sp. (Pl. 2/10-12).

Top: 7 m bauxite (Pl. 1/8), follwed by a thick sequence of plant-bearing siliciclastics (Shemshak Formation).

The Shemshak Formation (Norian-Bajocian) in the Jajarm area consists of a thick of red bauxite horizon (7 m) at the base and alternations of dark-green and purple, thin to thick-bedded sandstones, purple conglomeratic quartz sandstone, green, thin-bedded shales and coaly shales (plant-bearing) with intercalations of gray, medium to thick-bedded limestones and cherty limestones (Fig. 2 & Pl. 1/7).

Alternations of the Shemshak Formation mainly related to fluvial delta sedimentation environments and have been formed in foreland basins (Jahani, 2000).

The laterite and bauxite horizons in lower and upper boundaries of the Elikah Formation show sedi-

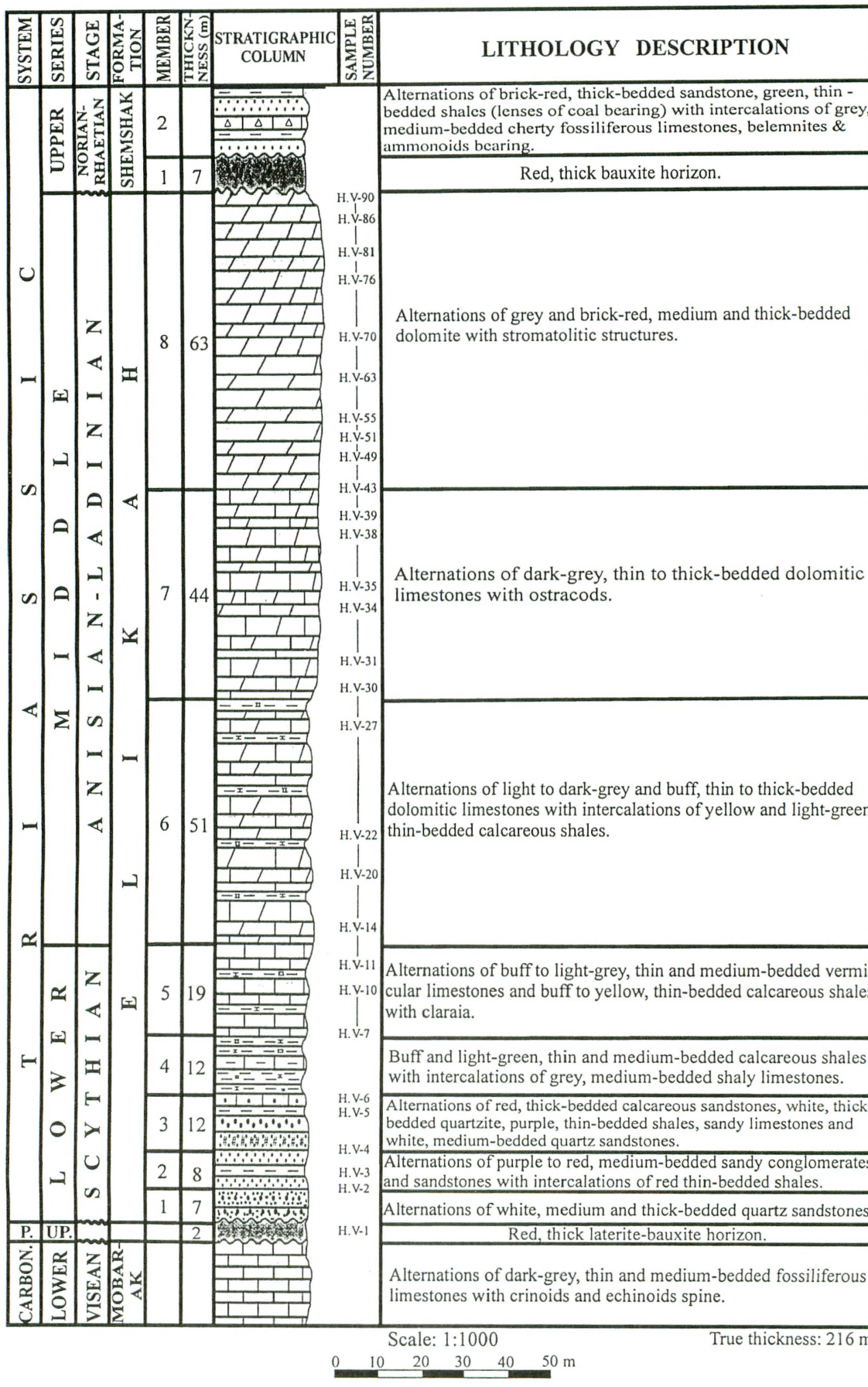

Fig. 2 Lithological characteristics of the Elikah Formation in the Jajarm area (eastern Alborz, North Iran).

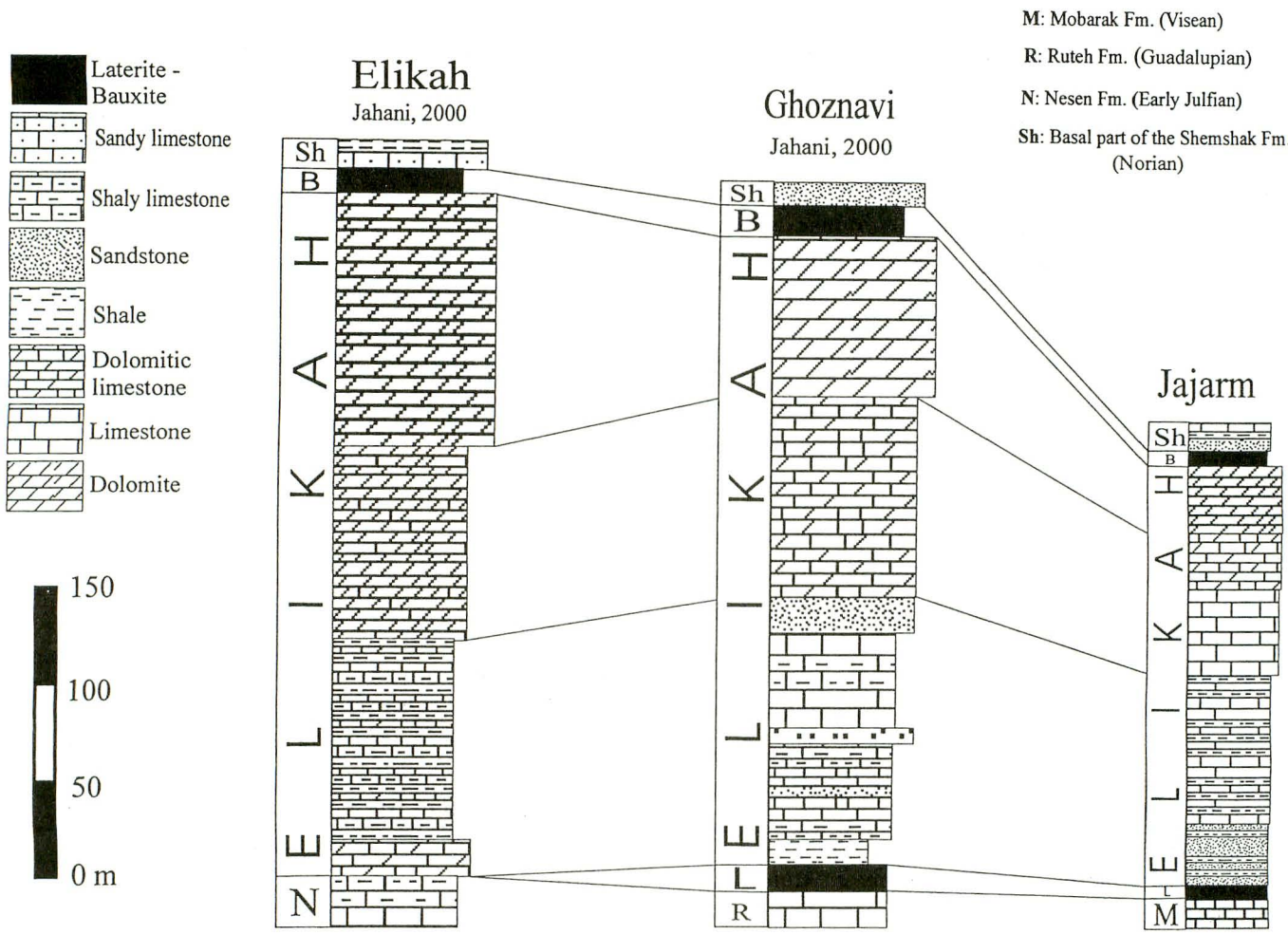

Fig. 3 Stratigraphic correlation among the Elikah Formation in type section (central Alborz), and Ghoznavi and Jajarm sections in eastern Alborz.

mentation gaps at these boundaries. The gap between the Elikah and Shemshak Formations is related to the Early Cimmerian orogenic phase that had resulted from the collision of the Iran and Turan plates. This collision in the Jajarm area probably occurred at early Late Triassic (Carnian) time.

Most geologists believe that the formation of the Shemshak Formation coincided with the Early Cimmerian orogenic phase with Late Triassic (Carnian-Norian) age (Aghanabati, 1988).

Sedimentary facies and depositional environment:

Sedimentary facies of the Elikah Formation in the Jajarm area are subdivided into three groups, including carbonates, siliciclastic, and mixed carbonate-clastic facies. The sedimentological and paleontological data indicate that this formation was mainly deposited from littoral, tidal and shallow shelf to open shelf-sea. There is no evidence of sedimentation in continental environments among the different rock types. The carbonate facies, showing various sedimentary structures and textural characteristics, have deposited in different sub-environments (upper tidal environments, littoral rise, lagoon, bioclastic barriers and different parts of open marine). Some rocks have laminations and cross lamination structures, indicating a tidal flat environment. Other deposits with micritic matrix belong to restricted marine environments. Some facies include bounded macrofossils such as gastropods and bivalves fragments and have accumulated as barriers. The siliciclastic facies have been mainly deposited along marine siliciclastic shorelines. The mixed facies types are related to mixed carbonate-clastic shelves.

1. Siliciclastic facies:

Alternations of quartz sandstones, sandy conglomerates, sub arkose sandstones, quartz arenites, quartzite,

sandstone and shale in members 1 to 3, were mainly deposited in barrier islands system related to marine siliciclastic shorelines. These facies show the beginning of Mesozoic transgression.

2. Carbonate facies:

Alternations of vermicular limestones with abundant biotrubation, dolomitic limestones and dolomites in members 5 to 8, mainly had formed in upper tidal environments, littoral rise, lagoon, bioclastic barriers and different parts of open marine in quiet environment. The most famous facies of this group is vermicular limestones (abundant bioturbation bearing).

3. Mixed carbonate-clastic facies:

Alternations of sandy limestones in member 3, shaly limestones and calcareous shales in member 4, calcareous shales in members 5 and 6 are related to mixed carbonate-clastic shelves.

The studies curried out by Jahani (2000) along central and eastern Alborz (Fig. 3) show that the Elikah Formation totally consists of three facies groups in shallow depth water environment:

1. Carbonate facies related to quiet condition
2. Carbonate facies related to stormy environment
3. Clastic facies

The lower sequences of the Elikah Formation are mainly composed of the quiet and stormy facies. The studies of above mentioned facies; especially the stormy facies have great importance in determining their origin, old seas, and geometric shape of basin. These studies show that the lower sequences of the Elikah Formation are carbonatic platform from homoclinal ramp type.

The middle and upper sequences of the Elikah Formation mainly consist of the facies associated with quiet conditions and evidences show that the sequences of the first stage of middle part of the Elikah Formation firstly deposited in an extensive platform ramp (Epiric platform).

Age of the Elikah Formation

Age of the Elikah Formation in the Jajarm area (Scythian-Ladinian) is determined by foraminifers (Fig. 4). Limestones of member 5 with Early Triassic (Scythian) age contain besides bivalves (*Claraia*), serpulids (*Spiorbis*) and the following foraminifers:

Earlandia sp., *Glomospirella* sp., *Glomospira* sp., *Meandrospira* sp., *Rectocornuspira* sp.

The lower member (lime member) of the Elikah Formation in type section (Pl. 1/1) and other areas of the Alborz Range also contain the following fossils:

Pelecypods:

Claraia sp., *Claraia aurita*, *Claraia stachei*, *Claraia clarai*, *Daneebites* sp., *Eumorphis* sp., *Homomya* sp., *Lingula tenuissim*, *Monotis* cf. *salinaria*, *Pleuromya* sp., *Posidonia* sp., *Pseudomonotis* sp., *Unionites* sp. (Stepanov et al., 1969; Nakazawa et al., 1981).

Ammonites:

Gyronites sp., *Meekoceras* sp., *Ophiceras* sp., *Protophiceras* sp. (Allenbach, 1966, Stepanov et al., 1969).

Conodonts:

Anchignathodus parvus, *Anchignathodus typicalis*, *Ellisonia teicherti*, *Ellisonia triassica*, *Isarcicella isarcica*, *Neogondonella carinata*, *Neohindeodella triassica*, *Spathognathodus isaricus*, *Spathognathodus typicalis* (Hirsch and Sussli, 1973; Kozur et al., 1975; Sweet, 1979).

The above-mentioned fossil assemblages indicate an Early Triassic (Scythian) age.

The upper member (Dolomite member) of the Elikah Formation in type section (Pl. 1/2) does not contain any index fossils. The age of this member is determined tentatively by their stratigraphic position as being Middle Triassic. In the Jajarm area this member (Pl. 1/6, 7) consists of dolomitic limestones and dolomites that contain the following foraminifers (Fig. 4 & Pl. 2/1-12):

Aeolisaccus? sp., *Ammodiscus* sp., *Angulodiscus* sp., *Bispiranella*? sp., *Diplotremina*? sp., *Earlandia* sp., *Glomospirella* sp., *Glomospira* sp., *Meandrospira* sp., *Meandrospiranella* sp., *Nodosaria* sp., *Pilaminella* spp., *Spiriamphorella*? sp., *Semiinvoluta* sp., *Textularia* sp., *Tolypammina* sp., *Ophthalmidina* sp., *Planiinvoluta* sp.

The above-mentioned fossil assemblages indicate a Middle Triassic (Anisian-Ladinian) age.

Age of the Elikah Formation may span up to Late Triassic (Carnian) in some parts of the Alborz Range. In few localities such as Aruh area (west of Firuzkuh)

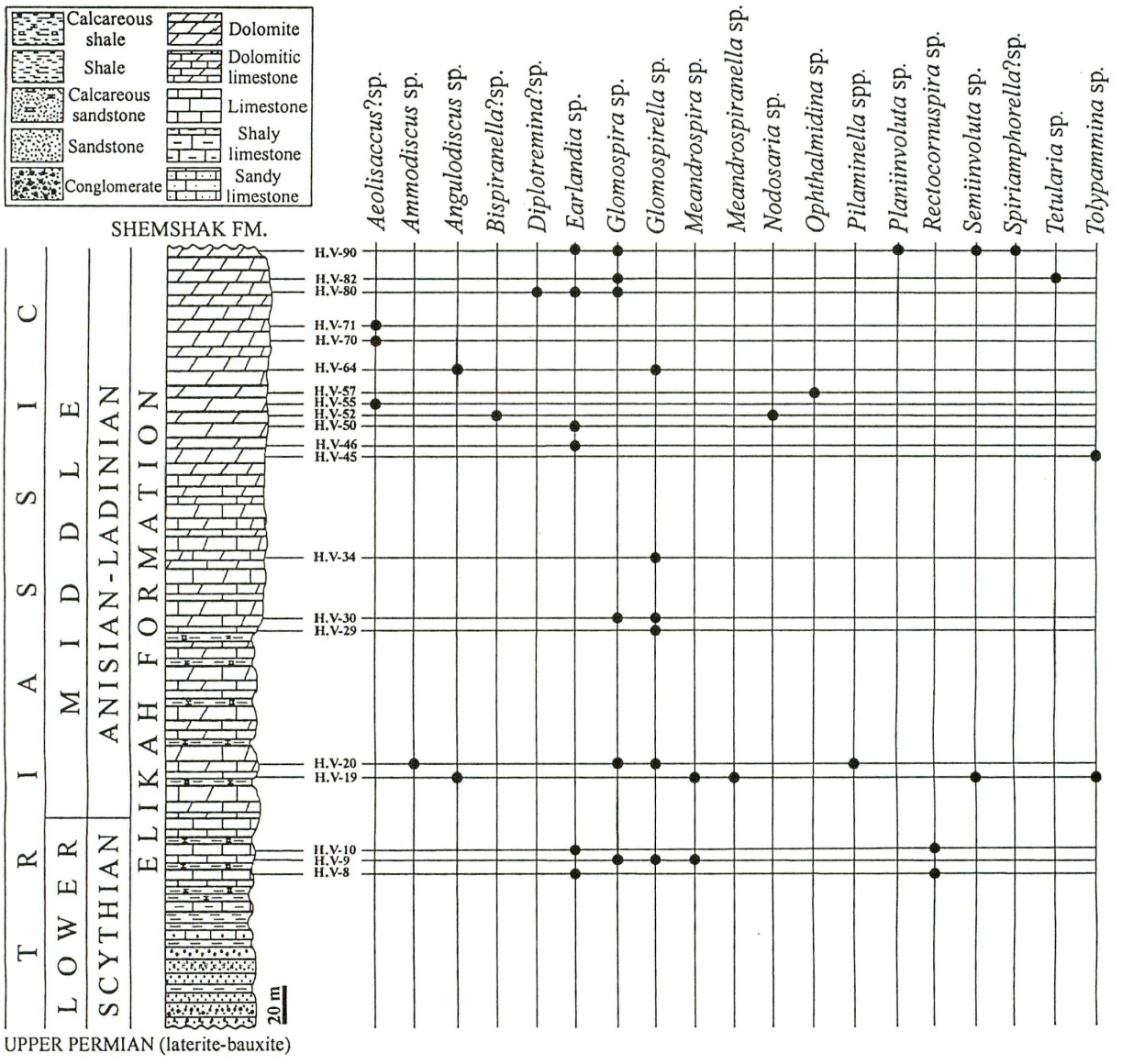

Fig. 4 Columnar section showing the horizons of foraminifers occurence at the Eliakh Formation in the Jajarm area.

and Veresk area (northeastern Firuzkuh) along central Alborz and Shahrud area in eastern Alborz (Fig. 1), where the pre-Shemshak erosional phase (Early Cimmerian tectonic event) has not been deep enough, a light algal limestone up to100 m (Aruh Limestone Member) builds up at the top of the Elikah Formation (Zaninetti et al., 1972; Stampfli et al., 1976; Nabavi, 1987; Jahani, 2000; Vaziri and Majidifard, 2001; Seyed-Emami, 2003). In the Shahrud area, this member contains serpulids (*Spiorbis*) and the following foraminifers (Vaziri and Majidifard, 2001):

Ammobaculites sp., *Involutina* sp., *Ophthalmidium* sp., *Reophax* sp., *Sigmolina* sp., *Trochammina* sp.

Summary

1. Lower and Middle Triassic sediments in northern Iran have been introduced and defined as the Elikah Formation.
2. The Elikah Formation consists of two members, lime member (Lower Triassic) and dolomite member (Middle Triassic) that in some parts of Alborz such as Aruh area (west of Firuzkuh) and Veresk area (northeastern Firuzkuh) along central Alborz and Shahrud area in eastern Alborz, a light algal limestone up to100 m (Aruh Limestone Member) builds up the top of the Elikah Formation and age of this

formation may span up to Late Triassic (Carnian).

3. The Elikah Formation in the Jajarm area in eastern Alborz attains a thickness of up to 216 meters and can be subdivided into two facies groups, a carbonate and siliciclastic facies in the lower part and a carbonate facies in the upper part.
4. Sedimentary facies of the Elikah Formation in the Jajarm area are subdivided into three groups, including carbonates, siliciclastic, and mixed carbonate-clastic facies. The sedimentary environments range from littoral, tidal and shallow shelf to open shelf-sea.
5. The rather poor foraminifer fauna in the Jajarm area indicates an Early to Middle Triassic (Scythian-Ladinian) age of the Elikah Formation.
6. The Elikah Formation overlies disconformably, via a lateritic-bauxitic horizon (2 m), Late Permian strata. On the top again the boundary to the overlying Shemshak Formation is disconformable and marked by a thick bauxitic horizon (7 m).
7. The gap between the Elikah and the Shemshak Formations is related to the Early Cimmerian orogenic phase that had resulted from the collision of the Iran and Turan plates. This collision in the Jajarm area probably occurred at early Late Triassic (Carnian) time.

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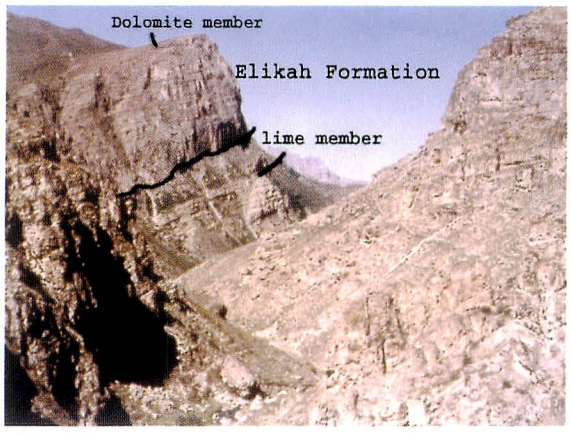
Plate 1

Fig. 1: The Elikah Formation in type section (central Alborz).
Fig. 2: The Elikah Formation in the Jajarm area (eastern Alborz).
Fig. 3: The laterite-bauxite horizon belongs to Upper Permian in the Jajarm area.
Fig. 4: The laterite-bauxite horizon of the Upper Permian and basal part of the Elikah Formation in the Jajarm area.
Fig. 5: Dolomitic limestones with intercalations of calcareous shales (member 6).
Fig. 6: Dolomitic limestones of member 7.
Fig. 7: Dolomites of member 8, and the Shemshak Formation.
Fig. 8: Dolomites of member 8 (Elikah Formation) and bauxite horizon at the base of the Shemshak Formation in the Jajarm area.

Plate 2

Fig. 1: *Meandrospiranella* sp., sample no. H.V.-19, x200
Figs. 2, 3: *Meandrospira* sp., sample no. H.V.-19, x200
Figs. 4, 5: *Angulodiscus* sp., sample no. H.V.-19, x200
Figs. 6-10: *Glomospirella* sp.
Fig.6: Sample no. H.V.-19, x200
Fig.7, 8: Sample no. H.V.-20, x200
Fig. 9: Sample no. H.V.-30, x200
Fig. 10: Sample no. H.V.-64, x200
Fig. 11: *Spiriamphorella*? sp., sample no. H.V.-90, x100
Fig. 12: *Earlandia* sp., sample no. H.V.-80, x100

Plate 1



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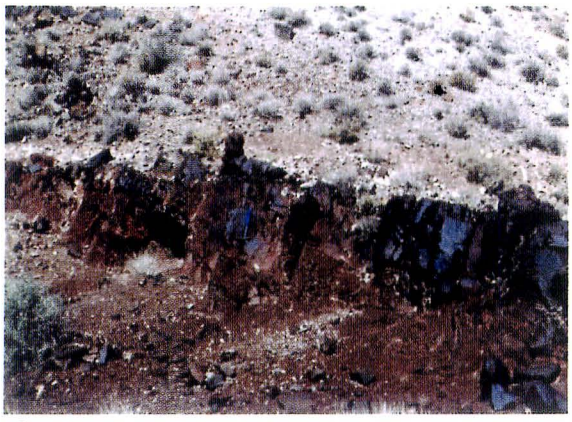

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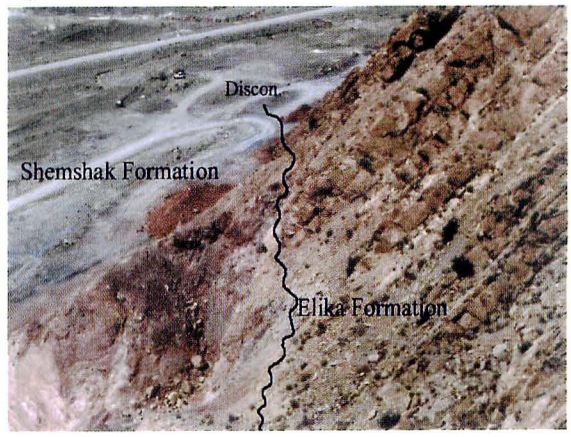

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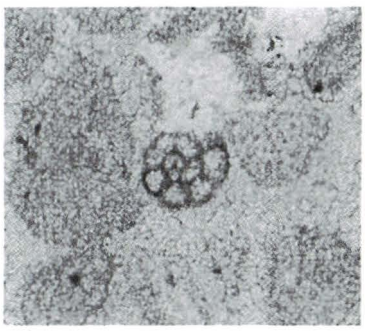

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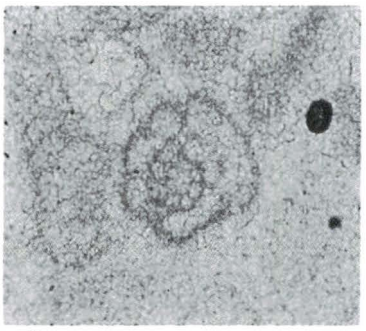

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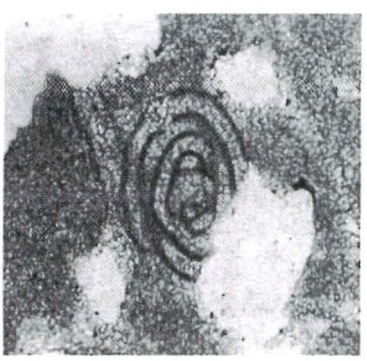

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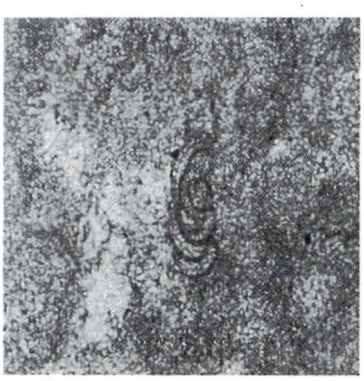

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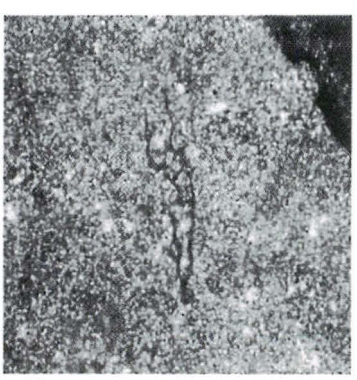
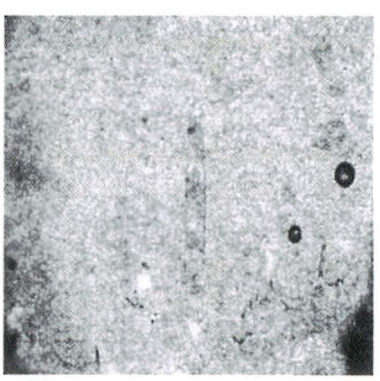


11



12